AN EXPERIMENTAL STUDY

OF

DERMAL SENSIBILITY.

Thesis For Degree of

A.B.

College of Literature and Arts.

David Hobart Carnahan.

U.of I.'96.

AN EXPERIMENTAL STUDY
of
DERMAL SENSIBILITY.

The lines of research pursued in this study of the successive stimulation of the various portions of the dermal area are as follows:-

I.To discover the relative sensitiveness of different portions of the skin.

2.To find the nature and direction of the errors in localization.

3.To study the influence of attention upon the localization and interpretation of successive touch stimulations;also the investigation of the problem of attention with especial reference to the question of how many successive sensations of touch the mind can attend to,or grasp.

4.To examine the effect of practice. Can the skin be educated to greater sensitiveness and accuracy in localization?

The experiments upon which this thesis is based were made in the psychological laboratory of the University of Illinois with Dr.W.O. Krohn and the writer,alternating as subjects.

LITERATURE.

As this line of work has received,as yet,but little attention in the scientific world,there is almost no literature bearing directly upon the subject. The main line of work,however,was taken from a somewhat similar study of simultaneous stimulations by Dr. W.O.Krohn reprinted from the Journal of Nervous and Mental Disease of March,I893.

APPARATUS.

Reference should be made to the accompaning illustrations in connection with the description.

The upright frame,A,is solidly made of wood,and securely fastened to the floor. The upright standards (E,E,)are of such a thickness as to permit the fastening of the clamps (C,C,)of which there are six. These clamps are after the Otis C.White pattern, with ball joints,and allow the adjustment of the half-inch nickel rods(B,B)at any angle. On these rods are sliding clamps (D,D) which admit a variety of adjustments; and through these clamps half-inch lead pipes are inserted (lead being chosen on account of its flexibility). To the end of these pipes are securely fastened small electro-magnets (Cut No.2). The armature,in this case, (g)is a flat strip of steel I X I/2 inches,secured at right angles to one end of a small steel lever about five inches in lenght(h).

The other end of this lever is bent at right angles and covered by a tapering cork. Corks are used because they arouse the purest and simplest touch sensations. This lever has for a fulcrum at the point O,a small double-pointed wire which fits loosely into the ends of the two adjustable screws(L,L),thus giving the lever almost perfect freedom. Below the end of the lever near the armature,is a spiral spring acting in opposition to the armature. Each magnet is connected by wires to the switch-board (S,S,). When the current is turned on,it magnetises the iron cores of the magnet which,in turn,attracts the armature,thus causing the lever to act, forcing the cork forward about an inch. Six of these magnets were used in the experiments.

Very little description is needed for the switch-board. Each magnet had eleven different connections through it,metal plugs being used to complete the circuit. An almost new piece of apparatus,however,for making the contacts was introduced,in order to secure a regular and equal time rate between the stimulations. This was the pendulum (P,P)swinging upon the knife edge at R and connected by wire with the battery, It completes the circuit of the various magnets when swinging,at (F,F),and when not needed is fastened by a leather catch at H. The contact board (F,F,)consist of the metal plate (T,T) into which are securely inserted the eleven 3/8 inch metal rods two inches long(W,W)set in a slight curve and wired to the switchboard. Near the outer end of each of these rods is a small hollow containing mercury. The pendulum has a sharp,pin-like point which,in swinging,passes through the mercury and completes the circuit. The metal plate is adjust-

able so that,the time between touches may be lengthened or shortened at will.

Method of Experiment.

The subject took his place in the frame and was blindfolded, keeping as nearly motionless as possible. The magnets were adjusted by means of the movable rods and flexible lead pipes so that the corks were within one-half inch of the skin of the subject,at different localities. The plugs were then arranged in the switchboard to produce any desired order of touches. The signal"Ready" was given and the pendulum from the point H,swung across to W and was there secured,having thus completed the circuit for each of the magnets in turn,thereby causing the corks to press against the skin at regular intervals of time. The spring on the magnet,already mentioned, immediately caused them to leave the skin. The subject then indicated the exact spots touched and the order in which the touches came. The actual order and spots touched were then written and results were computed from a comparison of the two lists. About seventy sets of experiments were made,each test being executed with special reference to the lines of investigation already stated. However,various other interesting facts were incidently obtained in the work and will be mentioned. A few examples of the tests,selected at random,are given here:

(I) (All on left side.)

Inside left knee.

Back left knee.

Back left thigh.

Two inches to left of navel.

Top left shoulder.

Outside left knee.

(2) (Well scattered.)

Between shoulders

Left ankle.

Right leg behind.

Right breast.

Left side abdomen.

Small of back.

(3) (Two pair bilateral.)

Right side abdomen.

Left side abdomen.

Right shoulder blade.

Left shoulder blade.

Back right leg.

Left ankle outside.

(4) (Joint)

Right elbow.

Left wrist.

Top right shoulder.

Top left shoulder.

Left foot,joint of great toe.

Back left knee.

(5) (In groups)

(5) (In groups)

Between shoulders.

Small of back.

Left side behind.

Left nipple.

Left side of abdomen.

Navel.

(6) (Upper part of body)

Right nipple.

Left nipple.

Navel.

Right shoulder blade.

Left shoulder blade.

Small of back.

RESULTS.

I. Evidence in regard to the relative sensitiveness of different portions of the skin.

The results secured under this head, show very clearly that the accuracy of the localizing power varies greatly on the different parts of the surface of the body.

(a) The localizing power of the skin over the joints is greater than that of any other portion of the dermal area. The following record of the joint stimulations, when compared with the record for the entire body, gives proof for this. The percentage of joint touches, correctly localized by one subject, W.O.K., was .8I, while his average of correct touches for the entire dermal area was .76

The other subject,D,H,C.had a percentage of .77 correctly localized for the joints and only .63 for the entire body.

The skin upon the back of the body is more sensitive for localizing touches than that on the front part. The following comparison of the touches on the back and front,respectively,may be given:-

Person	No.of touches		Percent cor.located.		Percent of errors	
	Back.	Front.	Back	Front	Back	Front
D.H.C.	65	56	.66	.5I	.33	.48
W.O.K.	42	35	.78	.74	.2I	.25

(c)Localization of the dermal sensations are better for points right side of the body than on the left. The following is the record:-

Person	No.of touches.		Percent correct		Percent of errors.	
	Right	Left	Right	Left	Right	Left
D.H.C.	I05	5I	.7I	.55	.29	.45
W.O.K.	3I	48	.87	.68	.I3	.3I

Various hypotheses might be given for this fact but no special study was made of it in this connection. The location of the heart might be given as one reason,and,again,the question of right or left handedness might be considered. Both the subjects in these experiments were right handed. No further consideration,however, will be given this question here. In addition to the table just given it was noticeable that in the case of bilateral touches,

such as upon the two shoulder blades, the error when made, was almost always the omission of the left touch and with this there was a drawing of the right touch a distance usually varying from one to three inches, towards the left (d). Those portions of the dermal area habitually covered by clothing were found to be much less sensitive to touch stimulations than the portions not covered. The following percentage is given:-

Person	Percent Correct		Percent of errors	
	Covered	Uncovered	Covered	Uncovered
D.H.C.	.62	.72	.37	.27
W.O.K.	.74	.90	.26	.10

II. Nature and Direction of Errors in localization. The errors may be divided into four kinds, without considering those arising from pure imagination. I. Errors of extension, confined to the limbs, in which the sensation is projected from the body towards the extremities; 2-3, Vertical errors, placing the sensation too high and too low; 4, Lateral errors on the limbs and body. The general percent of these errors in the experiments were as follows Extension, .26; vertical, high, .32; vertical, low, .22; lateral 15 ; while about .07 may be credited to imagination.

III. The influence of attention upon the localization, and its investigation with special reference to the time-order of the successive stimulations.

The importance of attention could easily be seen in a comparison of the results obtained, when the subject concentrated his mind upon the tests, with those obtained when the attention was distracted. In almost every case of the first kind, a good record

of localizing was made, while in the latter there was but a confused, general idea of being touched. If the signal " Ready" was omitted the result was always poor, the subject not having had the opportunity to fix his attention. Again, the result is poor when the subject expected the touches to be spread out over the entire body, and then they were grouped on the upper or lower part alone. When the touches are well scatterdd over the body and the attention is firmly concentrated on the test, the best records are made.

The second part of this question (NO. III,),with regard to the order or succession of the touches, is quite interesting. The stimulations coming, as they did, I/25 of a second apart, and demanding their share of the attention, furnished a good study in themselves. In a general way, order depends upon the same conditions as localization. The best results are obtained when the attention is firmly fastened upon the problem. The non-scattering of the points and the general idea of the portion of the skin to be stimulated are also important aids. However, one very noticable feature should be considered and that is that good localization and order-naming, do not go together. In fact it is just the contrary. When the localization is good the order-naming is poor and vice versa. This is shown by the following summary: From the entire number of tests, ten sets, comprising sixty separate touches, were taken from among the best in regard to localization, and ten sets from the best with reference to order-naming. In the first ten, the percentage of touches,correct was as follows; Localization, .8I; order-naming, .32. In the second ten, Localization, .53; order-naming .63.

In this order-naming, there is a tendency to omit the first touch, many of the tests having the actual second touch put down as the first. This would seem to indicate that the first touch merely attracts the attention, drawing it only in time to concentrate on the second touch. Some times when the attention is wandering, even the third touch is put first. In this connection also might be mentioned the super-sensitiveness of the face. When a touch is made on it, it seems to disturb and confuse not only the order but also the localization of all the succeeding stimulations.

IV. Practice plays a very important part in these experiments. In the preliminary tests where only four magnets were used and these upon the upper part of the body alone, the subject could only locate and name the order of two with any degree of certainty, while in the last few tests he could locate easily four of the six corks placed anywhere over the entire body. This is of course partly due to the mind training, but principally to the education of the skin.

The dermal after-images play an important part in the localization of the spots stimulated; In fact, many of the touches were localized entirely by means of this after-immage. Although there were many illustrations of this feature, perhaps the best one was in the case of W.O.K. He had named five out of the six spots but was unable to locate the sixth for some time; but after about three minutes the after-image (in this case it was upon the left calf) came out plainly and he located it correctly. Frequently, while adjusting the corks, the shirt sleeve of the ex-

perimentor would touch some part of the subject's skin and, through the after-image, would cause a false location, two minutes afterwards, while the subject was anming the cork touches. The strongest after-image seemed to be found on the calf and back of the legs.

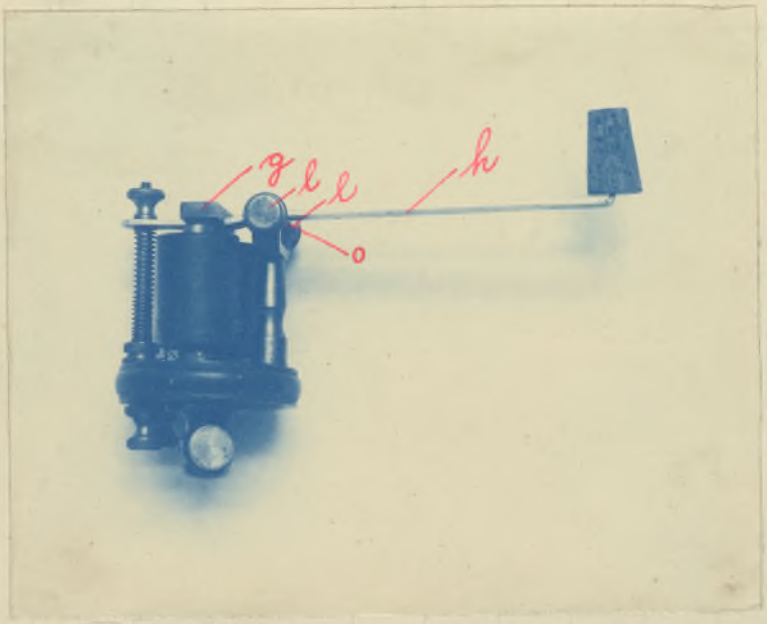
Although no.special attention was given to the subject of fusion, over twenty good cases were noticed where two or more stimulations fused into one, located at a point different from either. A few of the cases will be given here. D.H.C. fused two touches, located respectively between the shoulders and in the small of the back, into one, midway between the two. He also fuse fused the right nipple and right side of abdomen into one, about an inch to right of navel. Three, located down the middle of the back were located as one, directly in the center. W.O.K. fused two, one on the front of knee and the other on the calf into one on inside of knee. Two, one on left leg behind and the other on t the left calf, he located as one about four inches below the upper one. These cases seem to be more abundant upon the trunk and the fleshy parts of the limbs than upon the joints and more movable parts of the body.

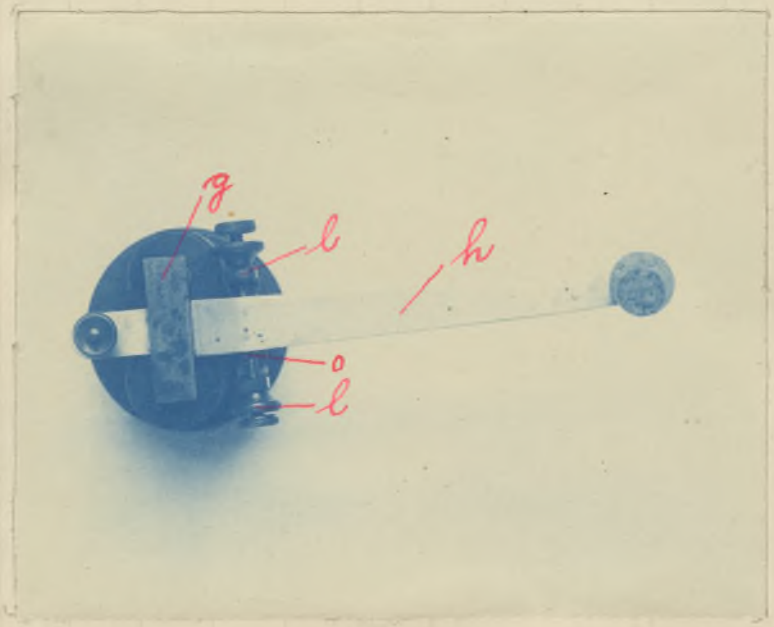
The imagined dermal sensations were quite numerous in the tests, about .07 of the errors in localization being credited to it. These imagined dermal sensations are entirely creations of the mind forming an after-image in a place where there was no touch stimulation. The best example of this was in the case of D.H.C. who during several series of experiments frequently located without stimulating a touch on the back of the right leg and

could find no reason for the error. Another touch was confidently located on the inside of the left heel, giving the exact spot, when, in reality, no touch was nearer than the outside of the left thigh. Other similar imagined touches were located on all parts of the body.

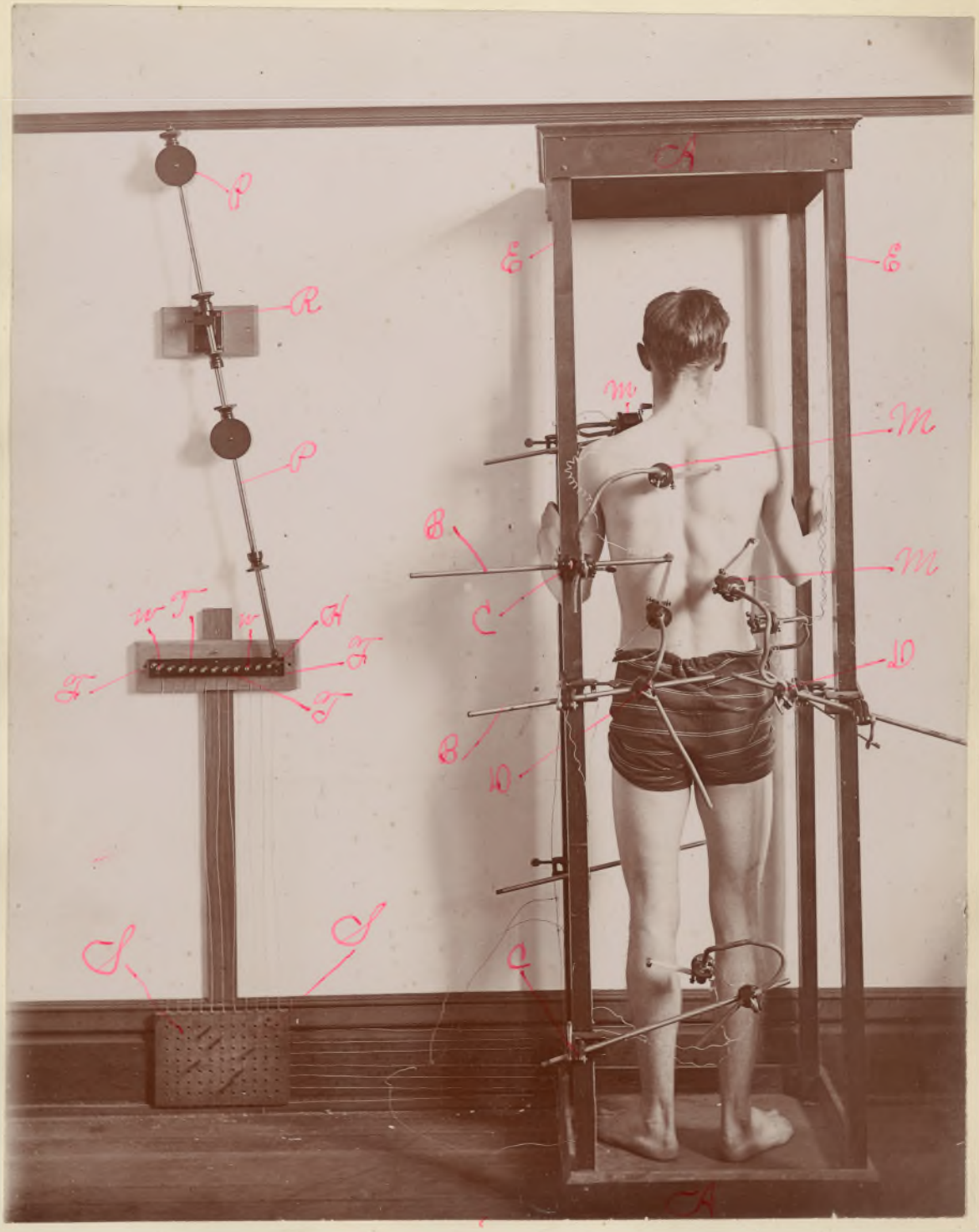
Very few cases of translocation were met with. This kind is where, when a point upon the surface of the body is touched, the sensation is experienced at a point exactly opposite. One of thes these is in the case of D.H.C. where the stimulus was applied at the tip of the right shoulder blade and located at the right nipple. Another was the translocating of a touch on the right fore-arm to the left fore-arm.

Great care was taken in regard to accuracy in these experiments. The subject was not allowed to become chilled or fatigued but was kept in a condition as nearly normal as possible. The results may be considered as quite satisfactory, reliable data having been secured along the desired lines of investigation and various other interesting and valuable facts, regarding the sense of touch having been discovered.





No. II.



No. I